Cryptosporidium: Replacing Giardia as New Superbug

Small Organisms Can Invade Water Treatment Systems

By: Tom Aucutt, Idaho Water Quality Bureau—Another intestinal parasite is now on the waterborne disease scene. This disease-causing organism or pathogen is known as *Cryptosporidium* (kripto-spor-rid-ee-um) and has been termed the "new superbug" of the water industry.

Cryptosporidium has been around for a long time and is well-known in veterinary literature as a cause of diarrhea in animals, especially calves. The protozoan parasite has also been isolated in sheep, dogs, cats, deer, mice, rabbits and snakes.

It's only recently been found to cause illness in humans. The first case of human cryptosporidioisis (the disease caused by *Cryptosporidium*) was reported in 1976. In 1984, it was learned that the disease could be transmitted by drinking contaminated water.

This organism has come into greater prominence with the recognition of its role as a cause of the debilitating diarrhea found in patients with the Acquired Immune Deficiency Syndrome (AIDS).

The organism can infect the entire bowel but most commonly the lower small intestine. The life cycle begins with the ingestion of the oocyst (o-a-sist), the infectious stage of the parasite, from contaminated food, water, or surfaces such as hands. The most reliable method of diagnosis, as in any parasitic disease, is stool-examination. The symptom that typically characterizes cryptosporidiosis is diarrhea which is often prolonged and can be accompanied by severe weight loss. Other symptoms include cramps and in some cases vomiting and low grade fever. Fortunately, the disease is self-limiting, meaning that it runs a definite and limited course.

In spite of a lot of diarrhea and perhaps some abdominal pain, immunologically healthy individuals should be completely symptom-free within a month and should not require treatment. This is fortunate because the pathogen appears to be resistant to a great variety of drugs that have been used successfully for treatment against other protozoan infections.

Some individuals may experience a waxing and waning of symptoms; a period of diarrhea may be followed by a week to 10 days without symptoms and then a second or even a third episode of diarrhea.

The first known infections of *Cryptosporidium* in humans were associated with exposure to farm animals indicating that the parasite is transmitted by the fecal-oral route. This cross-species transmission increases the potential for waterborne disease because animals, in addition to humans, may contaminate drinking water sources. A lack of contact with implicated animals by infected people also indicates that the organism is transmitted by person-to-person contact. This type of transmission has been documented in day-care centers and hospitals, and may play a major role in the spread of disease.

Children under two years of age may be the most susceptible and *Cryptosporidium* has become problematic in day-care centers. When cryptosporidiosis does occur in child-care centers, it is usually epidemic. Cryptosporidiosis has been reported among children attending day-care centers in Georgia, Pennsylvania, Michigan, California, New Mexico and Oklahoma. Research also shows that there is a rather high level of environmental contamination from *Cryptosporidium*, especially where sanitary conditions are lacking. In one study, flies captured within contaminated areas were found to harbor oocysts, thus demonstrating their potential role as transport hosts and indicating the likelihood of fecal-food contamination.

Municipal waterborne outbreaks

Municipal waterborne outbreaks of cryptosporidiosis were unrecognized until 1984 when a sewage-contaminated well was implicated in an outbreak of diarrhea in Texas. It was suggested that the contamination had percolated through the ground into the well. The well water was chlorinated but it appeared to have no effect on the organism.

In January of 1987, a major outbreak of cryptosporidiosis in Carrollton, Georgia was traced to a river serving as the municipal water supply. This case provided researchers the opportunity to investigate the first waterborne outbreak involving a surface water supply and a modern water treatment facility that utilized rapid sand filtration.

The investigations revealed the *Cryptosporidium* oocysts were able to breach the water treatment facility which was in compliance with the United States Environmental Protection Agency (EPA) and State of Georgia limits for chlorine residual, coliform bacteria, and turbidity levels. An estimated 13,000 residents (40% of people drinking municipal water) became ill.

Carrollton was meeting the federal and state wastewater treatment guidelines, but a combination of three major problems led to the outbreak. The first dealt with the practice of taking filters out of service and then restarting them without first backwashing them. The second was an ineffective method of chemically separating suspended solids. The third problem related to the need to improve turbidity measurement and the filter control rate.

It is estimated that to date, only about 15,000 cases of cryptosporidiosis in the United States have been attributed to drinking water. However, there probably have been other waterborne transmitted outbreaks that went unreported or unrecognized as cryptosporidiosis. Until recently, symptoms of giardiasis or cryptosporidiosis were diagnosed as general upset stomach or diarrhea.

Recent outbreaks of cryptosporidiosis in sources of drinking water here in the United States point out that virtually any animal found in a watershed can be considered a potential carrier of *Cryptosporidium* although cattle seem to be a significant host. *Cryptosporidium* oocysts are commonly found in pasture runoff and in wastewater treatment plants.

Crypto. and drinking water utilities

The threat of cryptosporidiosis outbreak is sufficient cause for utilities to upgrade facilities and reassess operating practices at their treatment plants. Under optimal conditions, however, utilities with conventional water treatment plants (using coagulation, sedimentation, and filtration) or with slow-sand filtration should be able to remove a high degree of *Cryptosporidium* organisms.

In a February, 1988, article, the *AWWA Journal* stated that "a utility treating water from a river with wastewater discharges upstream or from an area with intensive animal-based agriculture must have substantially higher treatment efficiency than one that is filtering water from a controlled watershed or a freshwater source with no upstream wastewater discharges."

Special disinfection studies have shown that doses far stronger than those used in water treatment, and more potent than required for *Giardia* inactivation, are ineffective against *Cryptosporidium*. Obviously, mechanical means of filtering out the parasite are more effective than chemical treatment such as chlorination. Filtration plants must rely on the same degree of treatment as required for *Giardia*, that is, minimizing turbidity breakthrough and optimizing filter performance.

Effective oocyst removal can be achieved with a properly designed and operated filtration facility. There can be no breakdown in this process though, because the traditional second protective barrier of post disinfection will not inactivate oocysts that pass the filters.

Steve Tanner, of the Coeur d'Alene Idaho Department of Enviornmental Quality Field Office, says that "slow-sand filtration is effective against *Cryptosporidium* if the system is well designed and operated." Slow sand filtration is a method of water treatment whereby water is continuously passed through a bed of specifically graded sand at a very slow rate (50-100 times slower than a rapid sand filter).

As the water passes through the sand, a biological population develops on top of, and within the sand bed. It is this biological activity and adsorption onto the sand grains that is responsible for removing and inactivating the oocysts.

The process relies on a system that has the proper type and depth of sand, a specified slow continuous rate of filtration and most importantly, says Tanner, a biological active or "mature" filter bed. The maturing process may take 1-4 months to develop and is usually recognized by a high level of coliform bacteria removal (greater than 98%) by the filter.

The more conventional rapid sand filtration relies on chemically coagulating the water prior to filtration and can also be very effective at removing oocysts from water. As with any type of water treatment, the effectiveness of removing oocysts is only as good as the design and operation of the water treatment plan.

Crypto. in Idaho

Cryptosporidiosis is not a reportable disease in Idaho, and the extent of the problem is not known. It is known, however, that in the Summer of 1988, there was at least one diagnosed case of cryptosporidiosis in the Treasure Valley area of Idaho.

Outdoor enthusiasts in Idaho may be at risk because, as in the case of *Giardia*, drinking untreated surface water is associated with the illness. In addition, there may be an increased risk of infection from swimming in polluted surface water.

Currently, the state does not have a monitoring program for *Cryptosporidium*. The oocysts, which measure 3-5 micrometers (about half the size of the *Giardia* cysts), are difficult to test for. The method of analyzing water samples for *Cryptosporidium* is time-consuming and expensive. It takes 8 to 10 hours to process one sample, and specialized equipment is needed; right now private labs charge more than $150 per test.

Although research is being conducted on waterborne transmission of *Cryptosporidium*, there is still a need to determine survivability of the cysts under various methods of water treatment. Current feelings are that a properly designed and operated water treatment plant capable of removing *Giardia* cysts, should also be capable of removing *Cryptosporidium* oocysts.

The 1986 amendments to the federal "Safe Drinking Water Act" recognizes that previous monitoring and treatment requirements did not go far enough to protect against the transmission of *Cryptosporidium* and *Giardia*. These amendments, which are due to be finalized in June, 1989, will require that all public water systems using surface water install or operate treatment plants in a manner that will assure the customers are protected against superbugs like *Cryptosporidium*.—*Idaho Clean Water, Winter 1988/1989*

Cryptosporidium and Giardia

Cryptosporidium and *Giardia*, another protozoan, are similar and often compared but they differ in major ways:

* *Cryptosporidium*'s small size (3-5 micrometers) requires better filter performance for removal than for *Giardia* cysts (8-12 micrometers).
* It appears that *Cryptosporidium* can survive longer under adverse environmental conditions.
* *Cryptosporidium* is more resistant to disinfectants.
* There is greater potential for animal-to-human transmission of *Cryptosporidium* than of *Giardia*.
* There is an absence of antiparasitic drugs to treat cryptosporidiosis.
* *Cryptosporidium* is self-limiting and *Giardia* is not.